JPRS: 4875

14 August 1961

THE VITAMINS OF TECHNICAL PROGRESS

By S. Kahanovych

-USSR-

Distributed by:

OFFICE OF TECHNICAL SERVICES
U. S. DEPARTMENT OF COMMERCE
WASHINGTON 25, D. C.

U. S. JOINT PUBLICATIONS RESEARCH SERVICE
1636 CONNECTICUT AVE., N.W.
WASHINGTON 25, D. C.

JPRS: 4875

CSO: 1879-S

THE VITAMINS OF TECHNICAL PROGRESS

/Following is the translation of an article by S. Kahanovych, scientific worker at the Institute of Mineralogy, Geochemistry and Crystallochemistry of Rare Elements of the Academy of Sciences USSR, in Znannya ta Pratsya (Knowledge and Work), No 5, Kiev, May 1961, pages 12-13./

At the beginning of the century harbor officials at Rio de Janeiro were greatly surprised when captains of some of the German ships returning to Europe stopped to take on cargo. Instead of bales of black coffee, the cargo holds were filled with ordinary sand washed ashore by the ocean surf. People who were used to thinking in commercial terms could not grasp this. It turned out that the Germans, possessing no raw materials for zirconium and rare elements but having discovered means to produce and use them in military technology, were hoarding zircon-monazite sands in a predatory way. The explanation for this strange behavior of German captains was found on the battlefields of the First World War, after the Allies had uncovered the mystery of the blindingly bright German signal rockets and understood the reason for the great density of smoke screens: the rockets contained powdery metallic zirconium and the smoke-pots -- salts of rare elements obtained from monazite.

Just as the quantity of horsepower determines the efficiency of an engine, so does the number of chemical elements actively used by industry determine to a considerable degree industry's power or, as it is sometimes said, its potential.

According to calculations made by Academician V. I. Vernadskiy, in earlier times mankind could only use 19 elements, in the 18th century -- 28, and in the 19th century -- 50. The second half of our century is characterized by the growing need of industry for new chemical elements, many of which, even though discovered 100 - 200 years ago, were very little used by man until recently.

Meanwhile, tantalum, lutetium, cerium, indium, plus

about 30 more rare elements, often having sonorous and even exotic names, comprise a large group making up one third of Mendelyeyev's periodic system.

The Second Birth

Until as recently as the forties of the 20th century, minutest particles of rare metals were produced by complex laboratory methods, costing many times more than gold. Owing to insufficient separation of the metals from admixtures, the physical and chemical properties of some of them were established erroneously. Titanium, zirconium and some other metals that contained admixtures of oxygen, hydrogen, and nitrogen were regarded as friable and unsuitable for machining. Other elements, for example, germanium could not display their unique "abilities" for the same reasons.

By now an industrial technology has been worked out which makes it possible to obtain all the rare metals in a particularly pure state. This enables us to utilize them to the fullest extent. All of them experienced thus their second birth. The increased use of the rare metals in modern technology is based on the fact that they possess many valuable properties which are either entirely absent in other metals or very little developed. In accordance with certain general features, they are for technical reasons conventionally subdivided into four groups: light (lithium, rubidium, cesium, beryllium), high-melting (zirconium, vanadium, niobium, tantalum), dispersed (gallium, indium, thallium, germanium, hafnium, selenium, tellurium, rhenium), and rare-earth elements (scandium, yttrium, lanthanum) and fourteen elements that follow them in the Mendelyeyev's table and are called lanthanides.

Rare Ones Become Widespread

Far-away seem those times when the principal purpose of lithium salts was the treatment of gout. Nowadays both lithium and its compounds find wide application -- from atomic reactors down to table-ware. In the molten state lithium is a good heat carrier -- this is the name for materials which are for carrying away heat in an atomic reactor. Lithium is the lightest metal (five times lighter than aluminum). Its specific gravity (0.53) is less than that of wood; for this reason it is called cork-weight metal. This makes it tempting to use the lithium-based alloys in aviation engineering and in transportation.

As yet, industry uses alloys containing small admixtures of lithium. To these belong "tinless babbitts", in which tin is substituted by lithium. Addition of only

0.04% of lithium increases the hardness of the alloy and reduces the friction coefficient, thanks to which seizing of bearings is eliminated. Lithium hydroxide solutions are used to fill alkaline-electrolyte batteries, and this increases their life by 2-300%. Lithium chloride is employed in air-conditioning units.

After having been treated with lithium compounds, rubber acquires frost-resistant properties and retains elasticity at rather low temperatures, which is of special value in the northern regions of the country where ordinary rubber breaks into pieces.

Lithium lubricating grease ensures continuous performance on the part of aircraft engines, operations in the scorching tropics, at the pole, or at an altitude of ten kilometers.

Take, for instance, berillium. Bronze containing from 0.5 to 3 percent berillium is widely used in instrument manufacture. Hammers, striking pins and bearings manufactured from such bronze differ from the rest of the components in length of service, diamagnetism; they do not produce sparks. As far back as in 1955 the Soviet delegation reported at the Geneva Conference that in the manufacture of atomic energy for peaceful purposes metallic berillium or its oxide is used to slow down neutrons in nuclear reactors and that methods have been developed of producing berillium oxide of high purity, as well as metallic berillium for nuclear engineering.

Is it possible to see in complete darkness? The answer happens to be yes, if cesium photocells are used. Under the influence of light cesium is able to convert light energy into electrical energy. Devices for seeing at night pick up infrared rays reflected by objects; with cesium photocells, it is possible to obtain the image of objects in the dark. This is but one of many instances of the use of cesium photocells.

The whole world has learned recently that every twenty-four hours the length of day increases by 0.00117 milliseconds. This fact has been established in the process of measuring time with a cesium clock -- the most precise "atomic clock" in the world. The role of cesium as a catalist -- a substance that speeds up chemical reactions -- also has possibilities.

A property of rare metals belonging to the high-melting group is, as the name itself indicates, a rather high melting temperature -- from 1,700^{o} in vanadium to 3,000^{o} in tantalum. Addition of close to one percent of niobium to chrome-nickel steel saves the steel, as an immunization does, from a dangerous disease -- so-called

transcrystallite corrosion which sets in when the steel is heated to more than 400 degrees. Addition of 0.5 percent of zirconium to magnesium alloys increases their mechanical strength during strong heating, stability and thus widens the temperature range and prolongs the length of their use.

The corrosion resistance of tantalum in vigorous media equals that of noble metals -- gold and platinum. Parts of chemical machinery made of tantalum have therefore, in effect, unlimited life. A tantalum heater weighing not more than one kilogram replaces a steel coil weighing one hundred kilograms, intended for heating a vat containing hydrochloric acid. In order to heat a cold tank with acid to 80 degrees, nine hours are necessary, whereas a tantalum heater does it in only two and one half hours; moreover, the former needs replacement every two months, and the latter may operate for many years.

Where a metal cannot withstand the temperature, certmic coating comes in handy, prepared on the basis of oxides of high-melting metals. Ceramets -- as these materials are called -- contribute much to the increase in the length of operation of combustion chembers and exhaust nozzles of turbo-jet motors and to protection of metal surfaces of satellites and rockets from heat. Special treatment of metallurgical furnaces, melting pots, and ladles with high-melting rare metal compounds prolongs considerably their life and increases the effective power of the unit. Until recently, pyrotechnics was the principal field where strontium was used -- "the metal of red fireworks". At present, over thirty different applications for strontium compounds are known. Thousands of tons of strontium hydroxide will be needed in order to obtain additional sugar from the waste product of its manufacture -- molasses. In addition, the latter will furnish potash and glutamic acid, which plays an important role in the metabolism of the brain and the central nervous system and is, in addition, a valuable pharmaceutical compound.

The Identicals Obtain Independence

In the course of recent years industry has gained fifteen new chemical elements (one sixth of Mendelyeyev's table) -- the group of the rare earths. The name "rare earths" was introduced by chemists in the 18th century; first, in order to indicate the relative rarity of those elements and, secondly, to show the likeness between their oxides and those of the alkali-earth metals.

The term "earth" means literally oxide and "rare

earth" -- that of an element belonging to a special group. Rare elements contained in minerals could not at first be separated because of the similarity of their properties, and they were used together in the form of a "mischmetal", mainly in metallurgy ("misch" means a mixture in English). /The mistake is in the original/ By now the identicals have become independent -- they may be obtained separately, and the properties of each may be used in industry. To be sure, the cost of rare-earth metals is as yet very high; they will, however, undoubtedly become cheaper, for was not metallic aluminum at first valued more highly than gold!

The rare-earth elements have already found their place in life. Yttrium, for instance, was formerly regarded as being too brittle for industrial use; new methods of processing have made it malleable. Lanthanum oxide is useful in the manufacture of special optical glass.

The Invisibles with Amazing Properties

Such properties are possessed by those rare metals which do not have their own minerals and are contained in microscopic quantities in compounds formed by other elements. Those are the dispersed metals. They are obtained from semi-products or waste from metallurgical plants which process ores. Metals which belong to this group have different properties. Gallium, for example, melts from the heat supplied by the palm of the hand, and rhenium is distinguished by the highest temperature of melting among all the metals, with the exception of tungsten. Another unusual property of rhenium is its ability to preserve hardness at a temperature reaching a thousand degrees, while other high-melting metals, tungsten included, become noticeably softer. Dispersed rubidium is used in photocells. An essential disadvantage of storage batteries is that they go out of order at low temperatures. Addition of rubidium hydroxide to the electrolyte ensures operation of the battery at 50 degrees below zero.

And now -- a little phantasy. 196.. We are attending the launching of a Soviet space ship to Mars. Its mighty hull is made of silvery rhenium; high temperatures will not endanger it in flight. Cesium has been chosen as fuel for the rocket motor because it becomes ionized at a comparatively low temperature. Rubidium serves as a heat-transfer agent for "warming up" the cesium. The ionic engine has been started. In a moment the ionized cesium vapors that leave the nozzle at an ever- increasing speed will carry the ship into space. The atomic reactor uses thorium, beryllium and zirconium. The screens serving to

protect the astronauts from radiation are made from gadolinium and hafnium; electronic devices built of dispersed metals possess semi-condictor properties characteristic of germanium and tellurium with indium solder and guarantee a reliable contact between metal and special glass. The ship's steering mechanism works faultlessly.....

...However, the rare metals are needed not only for the conquest of space. Without them no progress would be possible in nuclear power engineering, reactive power and rocket engineering, radioelectronics, chemistry; they enable us to automate the manufacturing industry, to introduce more productive technological processes, to obtain new materials, for today those are the true vitamins of technical progress.

Illustrations

Page 12: The periodic table contains nothing but Ukrainian names of those elements whose symbols are visible there.

Page 13: Picture on the left -- "a reaction motor" Label on the bottle next to it ---- "glutamic acid".

10,495

-END-